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EXAMINER	
BAUMEISTER, BRADLEY W	
ART UNIT	**PAPER NUMBER**
2815	

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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 09/461,756	Applicant(s) Kano
	Examiner B. William Baumeister	Art Unit 2815

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136 (a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *Feb 1, 2002*

2a)☒ This action is **FINAL.** 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11; 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-31* is/are pending in the application.

4a) Of the above, claim(s) *5, 6, 9, 12, 19, and 22-31* is/are withdrawn from consideratio

5)☐ Claim(s) ______ is/are allowed.

6)☒ Claim(s) *1-4, 7, 8, 10, 11, 13-18, 20, and 21* is/are rejected.

7)☐ Claim(s) ______ is/are objected to.

8)☐ Claims ______ are subject to restriction and/or election requirement

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on ______ is/are objected to by the Examiner.

11)☐ The proposed drawing correction filed on ______ is: a)☐ approved b)☐ disapproved.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. § 119

13)☒ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d).

a)☒ All b)☐ Some* c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. ______.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

*See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

Attachment(s)

15)☐ Notice of References Cited (PTO-892)

16)☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

17)☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s). *10*

18)☐ Interview Summary (PTO-413) Paper No(s). ______

19)☐ Notice of Informal Patent Application (PTO-152)

20)☐ Other:

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. Claims 1-4, 7, 8, 10, 11, 17, 18, 20 and 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tsuji et al. '068 in view of Takagi et al., "Design of Multi-Quantum Barrier (MQB) and Experimental Verification of MQB Effect." Tsuji discloses p-I-n light-receiving or photoelectric devices wherein a series of superlattice structures are separated by well layers (carrier accumulation layers) which are composed of the same material (having the same band gap) as the wells of the superlattice (see e.g., FIGs 10-12, col. 3, line 30 and col. 8, lines 14-25). The barrier and wells layers of the superlattice regions are dimensioned so as to cause reflection above the conventional or expected conduction energy band level, creating a virtual barrier thereabove. Tsuji makes reference to earlier works of Capasso (e.g., col. 2, lines 1-) but does not expressly set forth the theory or calculations employed to set the thicknesses of the wells and barriers so as to produce this virtual barrier in the superlattice regions.

a. Takagi teaches that a virtual barrier above the expected energy level of the barrier's conduction band may be produced by setting the thicknesses of the superlattices' barriers

and wells to odd multiples of a quarter-wavelength of carriers that are to traverse the superlattice. The equations for setting these thicknesses are exactly the same as the equation set forth in claim 3 except that Takagi teaches odd-multiples instead of even multiples as set forth in the present claims (n=even integer). (Mathematical calculations showing the relationship in terms of the layers' thicknesses have previously been included in other of Applicant's applications, including US Pat #6,188,083.) It would have been obvious to one of ordinary skill in the art at the time of the invention to set the superlattice barrier and well layers of Tsuji to odd multiples of a desired carrier wavelength according to Takagi for the purpose of improving the carrier reflectivity above the barrier conduction at these wavelengths as taught by Tsuji and Takagi.

b. The preceding explains why motivation exists to combine the references based on producing thicknesses that are odd multiples of a quarter wavelength of an energy, but does not address the limitation of the present claims that the thicknesses be even multiples. Nonetheless, once the teachings of these references are combined in the manner and for the reasons set forth above, the resultant structure will inherently satisfy all of the limitations of the stated claims, including the limitation that the thicknesses be even multiples of a carrier wavelength. This is because the wavelength of carriers traversing the superlattices and adjacent structures is a function of the applied energy. The carrier's energy, in turn, is a function of the voltage or bias applied across the device. Thus, for a device specifically designed to reflect a given energy E (superlattice is based on odd multiples), there inherently and necessarily exists some higher energy

E' such that $\lambda_{E'} = \lambda_E/2$.[1] Restated, when the thicknesses of the barriers and wells of this superlattice are designed so as to be odd multiples of the wavelength associated with energy, E, the thicknesses will be even multiples of this other energy E'.

The Examiner notes that a recitation of the intended use of the claimed invention must result in a structural difference between the claimed invention and the prior art in order to patentably distinguish the claimed invention from the prior art. If the prior art structure is capable of performing the intended use, then it meets the claim. See, e.g., *In re Pearson,* 181 USPQ 641 (CCPA); *In re Minks*, 169 USPQ 120 (Bd Appeals); *In re Casey*, 152 USPQ 235 (CCPA 1967); *In re Otto*, 136 USPQ 458, 459 (CCPA 1963). The language of this claim, as presented, does not distinguish the present invention over the combination of Tsuji and Takagi which possesses the same structure, as claimed.

c. Regarding claims 10 and 11, Tsuji discloses that the non-superlattice well (or carrier accumulation) layer where avalanche ionization takes place is designed to be very thin (e.g., col. 3, lines 52-56) but does not specifically disclose that the thickness is equal to the wavelength of the carriers. Nonetheless, it was well known that decreasing the thickness of the

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[1]The previous Office Action variously included typographical errors, stating the equation $\lambda_{E'} = 2\lambda_E$. This should have read as either $2\lambda_{E'} = \lambda_E$ or $\lambda_{E'} = \lambda_E/2$. This typographical error did not change the underlying rationale or bases of the rejections. Also, any confusion that may have potentially arisen from this mistake should have been obviated by the context of the equation in the Office Action.

avalanche photodetector will increase the carrier transit time, thereby improving the device's performance, so these well layers should be made as thin as possible. Further, the avalanche photodetector of Tsuji operates by the electrons gaining energy from falling into the well to produce an avalanche multiplication effect. Basic quantum physics principles dictates that in order for an electron to exist in a very thin quantum well the boundary conditions for the wave function must be satisfied such that the well thickness is a half wavelength of the carrier energy or a multiple thereof (e.g., particle in a box model). Restated, it would have been obvious to one of ordinary skill in the art at the time of the invention to form the well thickness to be equal to $n\lambda/2$ where n = an integer for the purpose of improving the device's operation. It would have been further obvious to specifically set the well thickness based on n = 1 (i.e. the thickness being $\lambda/2$) for the purpose of allowing the electron entering the well to reach the lowest possible energy level to further maximize the device's operation. In such a design configuration where the carrier accumulation layer is set to a thickness $d = \lambda_E/2$ for a carrier energy E, the region would simultaneously inherently satisfy the equation $d = \lambda_{E'}$ for the situation where a bias produces carriers having E' where $\lambda_{E'} = \lambda_E/2$, as was explained above.

3. Claims 13-16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tsuji/Takagi as applied to the claims above, and further in view of Motoda et al. '350. Tsuji/Takagi teaches all of the limitations of the claims as explained above except for the further inclusion of delta layers at the interface of the superlattices' barriers and wells. Motoda teaches that delta layers may be

employed at the interfaces of a superlattice's barriers and wells for the purpose of more sharply varying the energy band profile at this interface. Thus, it would have been obvious to one of ordinary skill in the art at the time of the invention to employ delta layers in the superlattice regions taught by Tsuji/Takagi for the purpose of more sharply varying the energy band profile, as taught by Motoda thereby further improving the desired reflection/transmission characteristic for which the superlattice is designed.

Response to Arguments

4. Applicant's arguments filed 2/1/2002 have been fully considered but they are not persuasive.

a. Applicant argues that the present invention is structurally different from that of the prior art and that the characteristics of the prior art device were not actually confirmed by experiment and that the calculation of the thickness is unclear (REMARKS, page 3).

i. Whether applicant's invention is, in fact, different is immaterial, because the references render obvious the invention *as claimed.*

ii. Takagi discloses that actual experiments were performed (see e.g., "Conclusions," therein). Further, the calculations or formulas set forth for determining thicknesses are identical to the formulas employed by Applicant in the claims. As such, the calculations must be sufficiently clear to enable one skilled in the art to make and use the device,

or else questions would be raised as to the definiteness and/or enablement of Applicants disclosure and claims.

b. Applicant argues that a MQIL designed towards reflecting a wavelength having an energy Eo cannot satisfy the conditions required to cause increased transmission of a different energy. To support or prove this argument, Applicant has provided attachments to the response (paper #12). The attachments and their calculations were fully considered, but careful review proves that Applicant's underlying premises for these calculations--and particularly the premises set forth in equations (2-1) and (1-1) of attachment 1A--are incorrect, rendering the position non-persuasive.

Specifically, Applicant asserts that E1 is obtained from "$n\lambda_B/4 = nD_B$; n is integer ≥ 2" (equation 2-1). This is not correct. This equation is assuming that for a higher energy E1 (having a proportionally lower wavelength), a different barrier thickness, nD_B -- as opposed to D_B -- is to be employed. This is not the examiner's position. Rather, the examiner's position is that when designing a barrier (or well) thickness so as to produce a 1/4 wave reflecting superlattice for reflecting carriers having a wavelength λ ($=\lambda_B = \lambda_W$) and an associated energy Eo, this thickness D_B will be set according to equation (2) as set forth in Applicant's attachment 1A. The well thickness D_W will similarly be set according to equation (1). These barrier/well thicknesses are not changed and do not change. Rather, when carriers having some higher energy E1 and an associated wavelength λ' confront the superlattice, these carriers will experience increased transmission if the voltage is adjusts so that E1 corresponds to a shorter wavelength $\lambda/2$. (See the

attachment to this Office Action for further calculations. Therein "λ_1" corresponds to " λ' " as used herein.)

c. Accordingly, Applicants arguments are not persuasive and the rejection is maintained.

Conclusion

5. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

INFORMATION ON HOW TO CONTACT THE USPTO

6. Any inquiry concerning this communication or earlier communications from the examiner should be directed to the examiner, **B. William Baumeister,** at **(703) 306-9165.** The examiner can normally be reached Monday through Friday, 8:30 a.m. to 5:00 p.m. If the Examiner is not available, the Examiner's supervisor, Mr. Eddie Lee, can be reached at (703) 308-1690. Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 308-0956.

B. William Baumeister

April 18, 2002

EDDIE LEE
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800

ATTACHMENT FOR 09/461,756 (PAPER #13)

According to quantum physics, carriers of respective energies E_0 and E_1 have respective, associated wavelengths of λ_0 and λ_1 where:

	$\lambda_0 = h/2(mE_0)^{½}$	(1a)
	$\lambda_1 = h/2(mE_1)^{½}$	(1b)
For the situation:	$E_1 = 4\ E_0$	(2)
Substituting (2) into (1b):	$\lambda_1 = h/2[m(4E_0)]^{½}$	(3)
Rearranging the terms:	$\lambda_1 = h/[2(mE_0)^{½}*2]$	(4)
Substituting (1a) into (4):	$\lambda_1 = \lambda_0 / 2$	(5)
Or, solving for λ_0:	$\lambda_0 = 2\ \lambda_1$	(5a)

Given a superlattice designed to reflect carriers of energy E_0 (e.g., Takagi), such that each barrier has a thickness D_B, where:

$$D_B = \lambda_0 / 4 \quad (6)$$

Substituting (5a) into (6) shows: $D_B = 2\ \lambda_1 / 4 = \lambda_1 / 2$ (7)

Similar calculation show that the same energy E_1 and it associated wavelength λ_1 also satisfies $D_W = \lambda_1 / 2$ when each well thickness D_W is set to $D_W = \lambda_0 / 4$. Accordingly, a superlattice having thicknesses D_B and D_W set to reflect the wavelength λ_0 will increase transmission of wavelength λ_1 for $\lambda_0 = 2\ \lambda_1$.

B. William Baumeister